

**MEGASTIGMUS FLORIDANUS (HYMENOPTERA: TORYMIDAE),  
NEWLY DISCOVERED IN ILEX SEED (AQUIFOLIACEAE)**

E. E. GRISSELL

Systematic Entomology Laboratory, PSI, Agricultural Research Service, USDA, c/o U.S. National Museum, NHB 168, Washington, D. C. 20560.

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*Abstract.* — *Megastigmus floridanus* Milliron was discovered to be phytophagous in seeds of *Ilex opaca* and one of its hybrids with *Ilex cassine*. This is the first report of a *Megastigmus* associated with Aquifoliaceae. A brief review of phytophagous wasps associated with *Ilex* seed is given, and adults and larvae of the two New World seed feeders (*Megastigmus floridanus*, *Torymus rugglesi*) are illustrated. Originally described from a single, unprepared specimen from Florida, *M. floridanus* was rediscovered there, where it was reared from *Ilex* × *attenuata*. It is newly reported from Maryland from an unknown cultivar of *Ilex opaca*. Here it was univoltine, overwintering as mature larvae in mature fruit. Adults emerged in May and June.

*Key Words:* *Megastigmus floridanus*, *Torymus rugglesi*, *Ilex opaca*, *Ilex* × *attenuata*, *Ilex* 'Foster #2'

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In June of 1982, Dr. Douglass Miller (USDA, ARS, Systematic Entomology Laboratory) discovered in Beltsville, Maryland a cultivar of *Ilex opaca* Aiton that was engulfed in adult female wasps of the chalcidoid genus *Megastigmus* Dalman. These wasps were emerging from mature red fruit that remained on the tree from the previous season. Species of *Megastigmus* are known to be seed-feeders, mainly on conifers and rosaceous plants, but have never been reported from *Ilex* (Lessmann 1962), nor any Aquifoliaceae.

I identified the wasp as *Megastigmus floridanus* Milliron by comparison with the single female holotype specimen collected in Florida in 1949. Nothing was known of its host or biology at the time of description, and no additional specimens have been found until this study. In 1987 I spent two weeks in Florida looking for *Megastigmus*

*floridanus* under the auspices of The Holly Society of America. In this paper information is presented on the rediscovery of *M. floridanus* in Florida and its discovery in Maryland. Preliminary data is presented on its biology as a phytophagous feeder in the seeds of cultivars of *Ilex opaca* and natural hybrids of *I. opaca* with *I. cassine* Linnaeus. A synopsis of holly seed-feeding wasps is given as well as methods to distinguish *M. floridanus* from *Torymus rugglesi* Milliron, the only other New World holly seed feeding wasp. The latter species is also reported for the first time from a commercial cultivar of *Ilex*.

PHYTOPHAGOUS WASPS IN *ILEX* SEED

At a world level, wasp species known to be phytophagous in *Ilex* seed are confined to the family Torymidae of the Chalcidoidea. This is the family to which *Megastig-*

*mus* belongs. Although most Torymid wasps are parasitic on other insects, there are several genera with phytophagous species.

*Bootania* Dalla Torre.—This Australasian genus is closely related to *Megastigmus* and has two species in Japan which feed in *Ilex* seed. *Bootania japonica* (Ashmead) occurs in seeds of *Ilex serrata* Thunberg and *I. purpurea* Hasskarl (reported as *shinensis* Sims, Kamijo 1962); *Bootania hirsutum* (Kamijo) occurs in the seeds of *Ilex integra* Thunberg (Kamijo 1962, 1981). Records for *japonica* and *hirsutum* prior to 1988 are under the generic name *Macrodasyceras* Kamijo which was recently synonymized under *Bootania* by Bouček (1988).

*Torymus* Dalman.—*Torymus rugglesi* (Figs. 2, 4) has been reared from the seeds of *Ilex opaca* in Delaware, Maryland, and Virginia (Milliron 1949). This species was omitted from "Field Guide to Insect Pests of Holly" by McComb (1986). During the period of 16 August to 30 September 1988, I discovered *T. rugglesi* emerging in large numbers from seeds of *Ilex* 'Foster #2' in Silver Spring, Maryland. This is the first record of the species from a cultivated *Ilex*. These specimens are in the collection of the U. S. National Museum of Natural History.

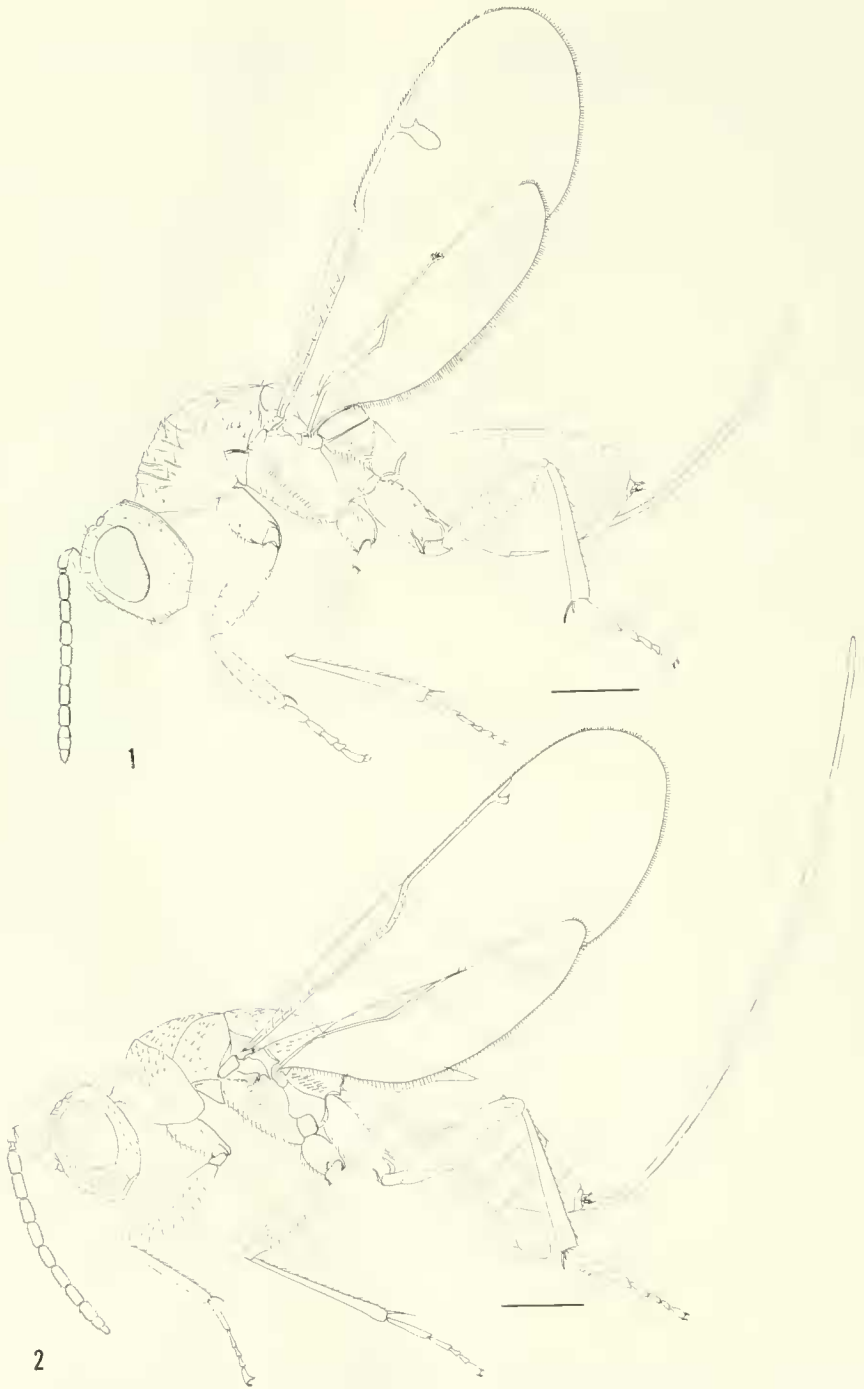
*Megastigmus*.—Only *Megastigmus floridanus* Milliron (Figs. 1, 3) is known from *Ilex*. Taxonomically *M. floridanus* may be distinguished from *T. rugglesi*, the only other phytophagous wasp with which it might be confused, by several characteristics. *Megastigmus floridanus* (Fig. 1) is entirely yellow, has an ovipositor that is about half the body length, and has the stigmal vein of the wing enlarged. *Torymus rugglesi* (Fig. 2) is metallic green dorsally and yellow on the remainder of the body, has an ovipositor that is slightly longer than the body, and has the stigmal vein barely indicated. The mature larvae of both species may be identified most easily based on setae. *Megastigmus floridanus* (Fig. 3) has setae confined to the first three body segments (excluding the head), whereas *T. rugglesi* (Fig. 4) has setae

over most of the body. Setae in both species are white or clear and can be overlooked.

#### MATERIALS AND METHODS

Field.—Over a five year period (1983–1988), observations were made at the USDA Beltsville Agricultural Research Center—West, Beltsville, Maryland, during the months of April through July. Initially two trees of *Ilex opaca* (unknown cultivar, det. T. R. Dudley) were found to be infested, but other trees within a one mile vicinity were swept and examined visually on a yearly basis for the presence of adult wasps. Because adults were abundant and fruit was readily available for dissection, I made no rearings from fresh fruit at Beltsville.

The search for Florida populations of *M. floridanus* centered upon Osceola County because the only known specimen of the wasp (the holotype) was collected there on 7 August 1929. Because the wasp I found in Maryland was on holly, I searched for habitats that could support holly species in general and *I. opaca* in particular. No specific locality was given within Osceola County, so I surveyed 23 localities over a nine day period from 1 to 9 August 1987. All hollies encountered were sampled with a sweep net for the presence of free-living, adult wasps. Both red (mature) and green (immature) fruit were collected when available and stored in paper bags that were placed in plastic bags to prevent excessive dehydration. Emergence was checked daily and all wasps were collected and killed in alcohol. Collections were also made about 100 miles north in the Ocala National Forest, Florida (Marion and Lake Counties) where nine sites were sampled over a three day period. Voucher herbarium specimens were taken from each tree from which a fruit collection was made and were determined to species by Dr. T. R. Dudley, U.S. National Arboretum, Washington, D.C. These specimens are now in the herbarium at the Arboretum. Reared wasp specimens were



Figs. 1, 2. Adult females (scale = 0.5 mm). 1, *Megastigmus floridanus*. 2, *Torymus rugglesi*, ovipositor extended upward in drawing, but normally horizontal or down-curved.

determined by me and are in the U.S. National Museum, Washington, D.C.

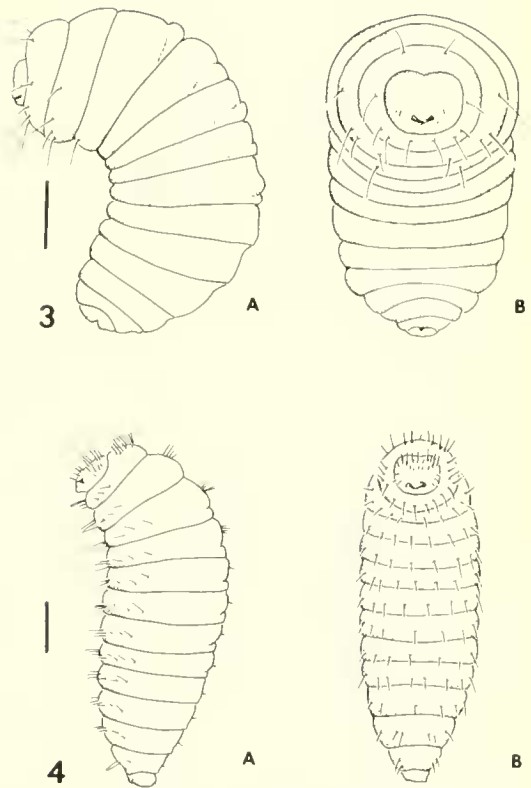
Laboratory.—Fruit for dissection was collected at Beltsville, Maryland from a single tree of *Ilex opaca* (one of the two mentioned above). This tree was part of a foundation planting and had been in place a number of years based upon the height of the tree (ca. 12 ft.). Because the presence of wasp larvae could not be determined by the external appearance of fruit, and because wasp larvae were difficult to find at the beginning of the study in 1983, fruit was first examined with x-ray equipment. After several years, as populations increased, larvae could be found in almost every fruit and dissections were made at random. Dissections were made the day after collection and larvae were killed in boiling water and stored in alcohol for future study. On one occasion, withered fruit from previous years' crops was taken from under the tree to determine if live wasps might be present in them.

#### RESULTS OF FIELD SURVEY

Florida.—During the Florida field survey I swept the following holly species: *Ilex ambigua* (Michaux) Torrey, *Ilex* × *attenuata* Ashe (*Ilex cassine* × *Ilex opaca*), *Ilex bushwellii* Small, *Ilex cassine*, and *Ilex glabra* Gray. No specimens of *Ilex opaca* were found. Only one free-living, adult female of *M. floridanus* was collected, and this was on *Ilex* × *attenuata*.

Fruit collections were made as follows (mature/immature): *I. ambigua* 0/1200, *I. × attenuata* 612/3970, *I. bushwellii* 0/100, *I. cassine* 0/16,500. Of these only *I. attenuata* produced wasp adults: 3 from mature (red) fruit and 116 from immature (green) fruit. These wasps emerged from fruit collected in Osceola County at Three Lakes Wildlife Management Area (25 mi. S. St. Cloud) and Prairie Lakes (29 mi. S. St. Cloud). Wasp emergence occurred from 7 to 26 August 1988.

*Ilex* × *attenuata* and *Ilex cassine* were the only hollies of those listed above that



Figs. 3, 4. Larvae of *Ilex* seed feeding Torymidae (A, side view, B, ventral view; scale = 0.5 mm). 3, *Megastigmus floridanus*, overwintering larva. 4, *Torrymus rugglesi*, mature larva.

exhibited all stages of floral development on the same tree at the same time. That is, every stage from bud and flower to immature green fruit and mature red fruit was available as a resource at one time.

Maryland.—During the period of study, adult, free-living *Megastigmus floridanus* were collected only in the months of May and June. Adults were seen exiting from mature, red fruit still attached to the tree. During the first four years, wasps were collected only on two trees which occurred within 100 feet of each other. Although other nearby female trees were swept (from 100 yards to a mile away), no wasps were found. In 1987, adult wasps were found for the first time on four trees about 100 yards to the east. Five trees 100 yards to the west had



no wasps. The tree first found to be infested with *M. floridanus* in 1982 still supported a large population of wasps in 1988.

The trees at Beltsville bloomed only in May and June. At that time, the previous season's mature red fruit remained on the tree, but there was no green fruit. After June there were no buds or flowers present and the developing fruit matured synchronously, reddening by early fall.

#### RESULTS OF LABORATORY DISSECTIONS

Larvae of *M. floridanus* were found to be solitary endophytes within an *Ilex* seed. Each *Ilex opaca* fruit produced four seeds. Among 28 infested fruit the most common number of larvae per fruit was 2 (65%), but 1 (14%), 3 (14%), and 4 (7%) larvae were also found. In randomly selected fruit sampled during July, August, and October from a heavily infested tree, 80 to 100 percent (avg. 93%) of the fruit ( $n = 30$ ) was infested. On a per seed basis ( $n = 120$ ), 38 to 63 percent (avg. 50%) were infested, 25 to 40 percent (avg. 34%) were distorted (indicating possible ovipositor probing and perhaps egg laying), and 12 to 23 percent (avg. 16%) appeared to be sound. There was no observable difference in appearance between infested and non-infested seed, and there appeared to be no obvious external affect on the growth of the holly fruit. A small, clean, circular emergence hole in the mature red fruit was the only evidence that *Megastigmus floridanus* had been present.

In 1987, I dissected 40 fruits (160 seeds) on 11 June and the same number again on 9 July and found no evidence of eggs or larvae. Larvae were first detected on 20 July and averaged 0.6 mm in length (range 0.4 to 0.9 mm,  $n=14$ ). As the overall seed infestation rate was 38 percent at this time, I probably overlooked the eggs and larvae on 11 June and 9 July. By 26 August the larvae averaged 2.4 mm in length (range 1.8 to 2.7 mm,  $n=17$ ) and by 1 October they averaged 2.3 mm (range 1.8 to 2.9 mm,  $n=21$ ). Random dissections of fruit in early January

yielded larvae which averaged 2.2 mm in length (range 2.1 to 2.5 mm,  $n=13$ ).

A single, incidental collection was made of old, blackened fruit from beneath a tree on 15 May. Forty seeds were dissected and contained three live adult females. This fruit could have fallen prematurely from the current year's crop or could have been on the ground for several years.

#### DISCUSSION

Milliron (1949) outlined a general life history for *Megastigmus* in which the female adult emerged in spring and immediately oviposited into immature host seeds; one larva developed per seed, attained full growth by late summer, and remained dormant over winter; pupation occurred in spring and adults emerged with the onset of new seed initiation. I believe that *Megastigmus floridanus* follows this developmental phenology at least in the Maryland population. Adult females were present in May and June, and small larvae were first detected in late July. Larval development was completed at least by late August after which time larval length remained approximately the same through January when dissections were no longer made. I believe that I overlooked egg and early larval growth in June and early July and found only mature larvae after the August dissections. Because mature larvae were present in January I assume that this is the overwintering phase.

*Ilex opaca* in Beltsville, Maryland had a definite seasonal phenology, with one crop of buds developing synchronically, then flowers, and then fruit. *Megastigmus floridanus* appeared to track this phenology and produced one generation per year. In Florida populations of *Ilex × attenuata*, all stages of floral and fruit development occurred simultaneously in August. Thus there was less synchronized fruit development than on Maryland trees and more overlap of available resources. It is possible that *M. floridanus* is multivoltine in Florida, but this was not determined.

In Maryland the discovery of adult females in fallen fruit of unknown age indicated the possibility of a small portion of the population diapausing for one or more years. Diapause is known to occur in *Megastigmus*, and Milliron (1949) cited examples of several species which have retarded emergences of up to two years. This is thought to be a method of ensuring a continuing wasp population in case there should be a year of poor or bad seed production. It would be interesting to determine what percent of a year's wasp population remains in diapause and how long such dormants might survive in fallen fruit on the ground. (I have observed phytophagous wasps of the genus *Eurytoma* emerging from seeds of *Rhamnus crocea* Nuttall over a four year period in the laboratory.)

It seemed surprising, at first, that *Megastigmus floridanus* was found in seeds of both *Ilex* × *attenuata* in Florida and *I. opaca* in Maryland. *Ilex* × *attenuata*, however, is a naturally occurring hybrid of *I. opaca* and *I. cassine* (T. R. Dudley, personal communication) so that the host trees are presumably closely related. What is more surprising, however, is that none of the seeds of pure *I. cassine* yielded adult wasps in spite of the large number of collected fruits (16,500). It may be that *I. opaca* and its hybrids are the only hosts suitable for *M. floridanus* development.

The known distribution of *Ilex opaca* is Massachusetts south to Florida, west to Pennsylvania and Texas (Eisenbeiss and Dudley 1973). *Megastigmus floridanus* might be expected to have the same distribution as its host tree, but additional surveying within this potential range will be necessary to determine this.

It is odd that only recently has an apparently common and widespread seed-feeding wasp been discovered on a common and widespread plant such as American holly. In Great Britain, records of the cultivation of introduced American holly extend back as far as 1744, and over 1,000 worldwide

selections have been given cultivar names in the last 40 years alone (Eisenbeiss and Dudley 1973). It would be interesting to discover the natural geographic and host range of *Megastigmus floridanus* and to determine what impact, if any, this seed-feeding wasp might have on its host trees.

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